

## SUBSTRATE CLEANING APPARATUS

### BACKGROUND OF THE INVENTION

The present invention relates to substrate cleaning apparatus, and in particular, to substrate cleaning  
5 apparatus which allows a simple and effective scrubbing-away of particles adhering to the end face and/or the bevel face of a substrate such as a semiconductor substrate, a glass substrate or a liquid crystal panel which requires a high degree of cleanliness.

10 In recent years, as semiconductor devices have been more densely packed, wiring in circuits on semiconductor substrates have been more highly-integrated and the distance between wires has been reduced. Especially in optical lithography with a distance between wires not  
15 greater than 0.5  $\mu\text{m}$ , a high degree of flatness is required on the image forming plane of a stepper due to a shallow focal depth. Further, if there is a particle of a diameter greater than the distance between the wires on the substrate, it may cause a problem such as a shorting  
20 between the wires or the like, and therefore it is important in a substrate processing to achieve cleanliness as well as planarization. Such circumstances may be common to a process for processing glass substrates used for masks and the like or substrates used for liquid-crystal  
25 panels and the like. These requirements have given rise to the need for a cleaning technique to remove sub-micron particles from the semiconductor substrate or the like.

For example, as a method for achieving a high degree

of cleanliness for a polished semiconductor substrate, a variety of methods have been suggested including scrub cleaning, in which a cleaning body composed of brush, sponge or the like is rubbed on the substrate; and a  
5 cavitation-jet cleaning in which a high pressure liquid (a high speed jet flow) is injected toward the substrate to generate air-bubbles by cavitation in order to clean the substrate.

However, there is a problem associated with the  
10 above-described prior art in that, although a surface of a substrate can be cleaned to a high degree of cleanliness, the end face and/or the bevel face of the substrate can not be cleaned efficiently, and as a result, those particles that have not been removed and remain on the end face  
15 and/or the bevel face of the substrate would be stuck on the surface of the substrate.

#### SUMMARY OF THE INVENTION

In the light of the above-described circumstances, an object of the present invention is to provide substrate  
20 cleaning apparatus which allows the end face and/or the bevel face of a substrate to be scrub-cleaned in a simple and also effective manner.

A first invention provides a substrate cleaning apparatus comprising: a plurality of substrate rotating  
25 rollers for gripping the periphery of a substrate and rotating the substrate; a cleaning roller capable of rotating and having a cleaning member which is to be brought into contact with the end face and/or the bevel

face of the substrate so as to apply scrub-cleaning to the end face and/or the bevel face; and a power transmission mechanism for transmitting a rotating force of at least one roller of the substrate rotating rollers to the cleaning  
5 roller so as to rotate the cleaning roller.

This allows the cleaning roller to be rotated in association with the revolution of the substrate rotating roller for rotating the substrate in order to clean the end face and/or the bevel face of the substrate, without any  
10 separate driving power source provided exclusively for the cleaning roller. Further, since the function for cleaning the end face and/or the bevel face of the substrate is designed to be performed independently, this function can be easily added to a cleaning apparatus of roller-sponge  
15 type or the like which has been commonly used, and also this function would not be an obstacle when cleaning the substrate by rotating it at a high speed.

A second invention provides a substrate cleaning apparatus according to the first invention, in which the  
20 power transmission mechanism has its revolution transfer ratio set such that there would be a relative difference in velocity between the peripheral velocity of revolution of the cleaning member and the peripheral velocity of revolution of the substrate. In this way, generating the  
25 relative difference in velocity between the peripheral velocity of revolution of the cleaning member and the peripheral velocity of revolution of the substrate allows particles to be scrubbed from the end-face and/or the bevel

face of the substrate in an effective manner.

A third invention provides a substrate cleaning apparatus according to either of the first or the second inventions, in which the apparatus further comprises a  
5 cleaning nozzle for injecting a cleaning liquid against the surface of the cleaning member to be brought into contact with the substrate. By means of this configuration, a cleaning liquid, such as ultrapure water or chemicals, which is suitable for removing particles, can be supplied  
10 from the cleaning nozzle to the cleaning member and the end face and/or the bevel face of the substrate.

A fourth invention provides a substrate cleaning apparatus in accordance with any of the first to the third inventions, in which the apparatus further comprises a  
15 force adjusting mechanism for adjusting the force of the cleaning member against the end face and/or bevel face of the substrate. This may allow the cleaning roller to be easily adjusted to an arbitrary position to optimize the force from the standpoint of cleaning ability and abrasion  
20 of the cleaning member.

A fifth invention provides a substrate cleaning apparatus in accordance with any of the first to the third inventions, in which the cleaning roller is rotatably supported on the free end of a swingable swing arm, wherein  
25 the swing arm is biased in the direction of bringing the cleaning member into contact with the end face and/or the bevel face of the substrate. This may also allow the end face and/or the bevel face of a flat oriented portion of a

substrate having the flat oriented portion to be cleaned by applying to the swing arm an appropriate bias force corresponding to the speed of revolution of the substrate.

A sixth invention provides a substrate cleaning apparatus according to any of the first to the fifth embodiment, in which the apparatus further comprises a contact-location adjusting mechanism for adjusting the contact-location of the cleaning member with the substrate in the vertical direction of the cleaning member. This may allow the cleaning member to be efficiently utilized over the full width in the vertical direction thereof by shifting the cleaning member in the height direction by an appropriate distance according to the amount of abrasion, thus using the cleaning member in an economical manner.

#### 15 BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a plan view illustrating a substrate cleaning apparatus of the first embodiment according to the present invention;

Fig. 2 is a cross sectional view taken along the line A-A of Fig. 1;

Fig. 3 is a cross sectional view taken along the line B-B of Fig. 1;

Fig. 4 is a fragmentary view taken in the direction designated by the arrow C of Fig. 1;

Fig. 5 is a fragmentary view taken in the direction designated by the arrow D of Fig. 1;

Fig. 6 is a partial plan view of the substrate cleaning apparatus, wherein each of 6(a) and 6(b)

illustrates different conditions where the amount of pushing force of a cleaning member against the substrate has been differently adjusted via a force adjusting mechanism;

5            Fig. 7 is a plan view illustrating a substrate cleaning apparatus of the second embodiment according to the present invention;

            Fig. 8 is a plan view illustrating main components of a substrate cleaning apparatus of the third embodiment  
10           according to the present invention;

            Fig. 9 is a diagram provided for explaining the power transmission mechanism of Fig. 8;

            Fig. 10 is a cross sectional view illustrating the contact location adjusting mechanism of a cleaning member,  
15           wherein each of 10(a) and 10(b) shows a different embodiment thereof;

            Fig. 11 is a plan view illustrating a substrate cleaning apparatus of the fourth embodiment according to the present invention; and

20           Fig. 12 is a side elevational view illustrating the cleaning liquid nozzle of the substrate cleaning apparatus of Fig. 11.

#### DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

            Preferred embodiments of the present invention will  
25           now be described with reference to the attached drawings.

            Figs. 1 to 6 show a substrate cleaning apparatus 1 of a first embodiment according to the present invention, wherein this substrate cleaning apparatus comprises a pair

of support bases 10, 10 respectively positioned in a front or a rear (or in a left or a right) side so as to be capable of moving horizontally to come close to or to go away from each other, each of the support bases 10, 10  
5 operatively supporting a pair of revolving rollers 12 and 14 so as to rotate freely, each of the revolving rollers 12 and 14 being disposed in a location to circumscribe the periphery of a wafer W. Further, each of the support bases 10, 10 is equipped with a substrate rotating mechanism 16  
10 for rotating the pair of substrate rotating rollers 12 and 14 arranged thereon synchronously with each other in the same direction thus to rotate the substrate W.

This substrate rotating mechanism 16 (Fig. 2) has a servo-motor 18, and a first timing belt 26 extends between  
15 so as to couple a first drive pulley 20 fixedly attached to the output shaft of the servo-motor 18 and a first driven pulley 24 fixedly attached to the lower end of a rotary shaft 22 of one substrate rotating roller 12. Further, a second timing belt 34 extends between so as to couple a  
20 second drive pulley 28 fixedly attached to an intermediate location along the longitudinal direction of the rotary shaft 22 of the one substrate rotating roller 12 and a second driven pulley 32 fixedly attached to the lower end of a rotary shaft 30 of the other substrate rotating roller  
25 14. To this second timing belt 34, a tension pulley 36 is applied for regulating the tensile force of the second timing belt 34.

In the mechanism, the one substrate rotating roller

12 is coupled with the upper end of the rotary shaft 22 supported by bearings 38 and 40 (see Fig. 3) so as to rotate freely, while the other substrate rotating roller 14 is coupled, into one body, with the upper end of the rotary shaft 30 supported by the bearing 40 (see Fig. 3) so as to rotate freely.

In this configuration, when the servo-motor 18 starts to drive, the one substrate rotating roller 12 is rotated together with the rotary shaft 22 via the first timing belt 26 and thus, in association with the revolution of the rotary shaft 22, the other substrate rotating roller 14 is rotated together with the rotary shaft 30 to be synchronized with the one substrate rotating roller 12 in the same direction via the second timing belt 34.

On respective top portions of the substrate rotating rollers 12 and 14, there are formed gripping grooves 12a and 14a for gripping the substrate W, into which the periphery of the substrate W is to be inserted, wherein, the substrate W is placed in a predetermined position surrounded by the substrate rotating rollers 12 and 14; the periphery of the substrate W is gripped in the gripping grooves 12a and 14a by moving each of the pair of support bases 10, 10 in respective directions to bring them closer to each other; and in this condition, by rotating the substrate rotating rollers 12 and 14 in the same direction in synchrony with each other, the substrate is rotated; while the substrate W is released from the gripped state by moving each of the pair of support bases 10, 10 in



respective directions to bring them apart from each other.

Further, a pair of cleaning members 42 for scrub-cleaning are operatively arranged above and beneath the substrate W having been gripped by the substrate rotating rollers 12 and 14, so as to move upward and downward, and to rotate freely, each of the cleaning members being composed of, for example, an elongated cylindrical roll sponge or the like extending along the full length along the diameter of the substrate W. A cleaning liquid is supplied to the vicinities of the cleaning members 42, 42 by nozzle "N" from an upper and a lower sides respectively. Thereby, under a condition where the substrate W is rotated at a rotating speed of, for example, 100r.p.m. in a manner described above, the substrate W can be scrub-cleaned over all areas of the top and the bottom surfaces thereof by bringing the cleaning members 42, 42 into contact with respective surfaces of the substrate while rotating the cleaning members 42, 42 on their respective axes.

The substrate cleaning apparatus according to this embodiment is further provided with a mechanism described below to apply a scrub-cleaning to the end face and/or the bevel face of the substrate W in addition to the function of applying the scrub-cleaning to the top and the bottom surfaces of the substrate as described above.

That is, as shown in Fig. 3, a cleaning roller transfer base 44 is arranged on one of the support bases 10, and a cleaning roller 48 is rotatably supported via a bearing 50 on a support rod 46 vertically mounted on the

transfer base 44. Further, a ring shape of cleaning member 52 made of, for example, sponge or the like is fixedly attached to the cleaning roller 48 at a location in the upper portion thereof, with which location the end face and/or the bevel face of the substrate W is brought into contact when the substrate W is gripped by the substrate rotating rollers 12 and 14. The cleaning member 52 is to be brought into contact with the end face and/or the bevel face of the substrate W so as to perform the scrub-cleaning to remove the particles sticking thereto.

The support base 10 is provided with a guiding slot 10a extending along the diametrical direction of the substrate, and a convex portion 44a to mate with this guiding slot 10a is arranged in the bottom face of the cleaning roller transfer base 44. Further, next to the cleaning roller transfer base 44 is vertically mounted a bracket 57 with a nut 56 attached thereto so as to be engaged by thread with a force adjusting bolt 54 extending in parallel with the guiding slot 10a, and a pushing piece 58 is vertically mounted on the cleaning roller transfer base 44, the pushing piece including a female thread portion to be engaged with the tip portion of the force adjusting bolt 54. Herein, the force adjusting bolt 54 is adapted to be engaged with the nut 56 and the female thread portion arranged in the pushing piece 58 in varying pitches, and thereby making up a force adjusting mechanism for adjusting the force of the cleaning member 52 against the substrate W.

In this example, as the force adjusting bolt 54 is rotated in the fastening direction from the condition illustrated in Fig. 3 (where the overlap of the cleaning member 52 with the substrate W is 1 mm), the cleaning roller transfer base 44 is guided by the guiding slot 10a and the convex portion 44a to be moved away from the substrate W due to the difference in pitch between the nut 56 and the female thread portion arranged in the pushing piece 58, resulting in the condition as shown in Fig. 6(a) (where the overlap of the cleaning member 52 with the substrate W is 0 mm), while in contrast, as the force adjusting bolt 54 is rotated in the unfastening direction, the cleaning roller transfer base 44 is guided by the guiding slot 10a and the convex portion 44a to be moved closer to the substrate W due to the difference in pitch between the nut 56 and the female thread portion arranged in the pushing piece 58, resulting in the condition shown in Fig. 6(b) (where the overlap of the cleaning member 52 with the substrate W is 3 mm).

Herein, the cleaning roller transfer base 44 is mounted to the support base 10 by two check bolts 62, and an elongated hole 44b extending in parallel with the guiding slot 10a is formed in the cleaning roller transfer base 44 at each location through which each of the check bolts 62 penetrates. Thereby, upon adjusting the position of the cleaning roller transfer base 44 by rotating the force adjusting bolt 54 as described above, the check bolts should have been first unfastened and then should be

fastened after the completion of the adjustment, so that this operation would not be obstructed and that the cleaning roller transfer base 44 is fixed onto the support base 10.

5           The cleaning roller 48 is adapted to rotate via a power transmitting mechanism 64 in association with the revolution of the substrate rotating roller 14. That is, in this example, an outer peripheral face of the substrate rotating roller 14 is fittingly attached with a driving  
10   frictional ring 66 made of material with a high friction coefficient, such as urethane or the like, and also an outer peripheral face of the cleaning roller 48 at a height corresponding to the driving frictional ring 66 is fittingly attached with a driven frictional ring 68 made of  
15   material with a high friction coefficient, such as urethane or the like. In addition, an intermediate roller 70 is rotatably supported and disposed between the substrate rotating roller 14 and the cleaning roller 48, and an intermediate frictional ring 69 made of material with a  
20   high friction coefficient, such as urethane or the like is attached onto the outer peripheral face of the intermediate roller 70 at a location in the height corresponding to the driving frictional ring 66 so as to be brought into compressive contact with both of the driving frictional  
25   ring 66 and the driven frictional ring 68. These components make up a power transmission mechanism 64 taking advantage of the friction force between the components, in which the cleaning roller 48 is driven to rotate in the

same direction as the substrate rotating roller 14 via the intermediate roller 70 when the substrate rotating roller 14 rotates.

Herein, a diameter d1 of the gripping groove 14a of the substrate rotating roller 14 and a diameter d2 of the cleaning member 52 are determined such that the ratio between them should be a value other than 1 ( $d1/d2 \neq 1$ ) in order to generate a relative velocity difference between a peripheral velocity of revolution of the cleaning member 52 and the peripheral velocity of revolution of the substrate W. In this way, providing the relative velocity difference between the peripheral velocity of revolution of the cleaning member 52 and the peripheral velocity of revolution of the substrate W allows the end face and/or the bevel face of the substrate W to be scrub-cleaned effectively by the cleaning member 52 so as to remove particles sticking thereon.

Further, the intermediate roller 70 is rotatably supported via a bearing 76 on a support rod 74 vertically mounted on an intermediate roller transfer base 72. Further, a bracket 80, through which a position adjusting bolt 78 is to be penetrated, is vertically mounted at a location external to the intermediate roller transfer base 72, while a pushing piece 82 with a female thread formed therein to be engaged through thread with the position adjusting bolt 78 is vertically mounted on the intermediate roller transfer base 72. By means of this configuration, the intermediate roller transfer base 72 may be moved

outwardly as the position adjusting bolt 78 is rotated in the fastening direction, while in contrast, the intermediate roller transfer base 72 may be moved inwardly as the position adjusting bolt 78 is rotated in the  
5 unfastening direction, so that the pushing force (friction force) of the intermediate frictional ring 69 against the driving frictional ring 66 and the driven frictional ring 68 can be adjusted.

Thus, even when the force of the cleaning member 52  
10 against the substrate W is adjusted via the force adjusting mechanism 60 as described above, the friction force of the intermediate frictional ring 69 against the driving frictional ring 66 and the driven frictional ring 68 can be prevented from falling into any excess or deficiency by  
15 adjusting the pushing force of the intermediate frictional ring 69 against the driving frictional ring 66 and the driven frictional ring 68.

Herein, the intermediate roller transfer base 72 is mounted to the support base 10 with two check bolts 84, and  
20 an elongated hole 72a extending in parallel with the position adjusting bolt 78 is formed in the intermediate roller transfer base 84 at each location through which each of the check bolts 72 is to be penetrated. Thereby, upon adjusting the position of the intermediate roller transfer  
25 base 72 by rotating the position adjusting bolt 78 as described above, the check bolts 84 should have been first unfastened and then should be fastened after the completion of the adjustment, so that this operation would not be

obstructed and that the intermediate roller transfer base 72 is fixed onto the support base 10.

In accordance with the substrate cleaning apparatus having a configuration described above, the end face and/or  
5 the bevel face of the substrate can be scrub-cleaned effectively by the cleaning member 52 in such a manner that primarily, a pair of support bases 10, 10 are moved closer to each other so as to grip the peripheral portion of the substrate W by the gripping grooves 12a and 14a; then, in  
10 this condition, when the substrate rotating roller 12 and 14 are rotated in the same direction in synchrony with each other to rotate the substrate W, the cleaning roller 48 is rotated via the power transmission mechanism 64; and thereby the relative velocity difference generated between  
15 the peripheral velocity of revolution of the cleaning member 52 and the peripheral velocity of revolution of the substrate W helps the end face and/or the bevel face of the substrate W be scrub-cleaned by the cleaning member in contact with those faces in an effective manner. By, under  
20 this condition, bringing the cleaning members 42 into contact with the substrate W while rotating the cleaning members 42 on their respective axes, the scrub-cleaning may be performed covering entire areas on the top and the bottom surfaces of the substrate W, which allows the end  
25 face and/or the bevel face to be scrub-cleaned simply and effectively.

Then, the cleaning operation having been finished, the rotation of the substrate rotating rollers 12 and 14 is

stopped so as to stop the revolution of the substrate W,  
and each of the pair of support bases 10, 10 is moved away  
from the other to release the substrate W from its gripped  
condition, where stopping of the rotations of the substrate  
5 rotating rollers 12 and 14 results in automatic stopping of  
the rotation of the cleaning roller 48.

Fig. 7 shows a substrate cleaning apparatus according  
to the second embodiment of the present invention, in which  
the cleaning nozzle 86 is arranged next to a cleaning  
10 roller 48 for injecting a cleaning liquid toward the face  
of the cleaning member 52 to be brought into contact with  
the substrate W. The rest of the configuration of the  
second embodiment is the same with that of the first  
embodiment. According to this embodiment, supplying  
15 cleaning liquid such as ultrapure water or chemicals from  
the nozzle 86 between the cleaning member 52 and the end  
face and/or the bevel face of the substrate W may  
effectively remove particles sticking thereon. It is to be  
noted that the pure water applied ultrasonic waves may be  
20 supplied from the cleaning nozzle 86.

Figs. 8 and 9 show a substrate cleaning apparatus of  
the third embodiment of the present invention, in which a  
swing arm 90 is provided and a cleaning roller 48 is  
rotatably supported on the free end of the swing arm 90,  
25 wherein the swing arm 90 is biased toward the substrate W  
by a spring 92, and friction force and a belt are used as  
the power transmitting mechanism 94.

That is, a rotary component 96 is operatively



arranged next to the substrate rotating roller 14 so as to rotate freely, the rotary component coming into compressive contact with the outer peripheral surface of the substrate rotating roller 14 so as to be rotated in association with  
5 the revolution of the substrate rotating roller 14, and the base end of the swing arm 90 is fittingly supported with some play by a rotary shaft 98 of the rotary component 96 so as to be prevented from moving up and down, while a cleaning roller 48 is rotatably supported on the free end  
10 of the swing arm 90. The swing arm 90 rotatably supports a driven rotating disc 102 which comes into compressive contact with a driving rotating disc 100 rotating together with the rotary component 96 in one unit, so as to rotate as the driving rotating disc 100 rotates, and a timing belt  
15 108 extends between a drive pulley 104 rotating together with the driven rotating disc 102 in one unit and a driven pulley 106 attached to the outer peripheral surface of the cleaning roller 48, so as to couple them, and thereby a power transmission mechanism 94 is configured.

20 That is, as the substrate rotating roller 14 rotates, the rotary component 96 is rotated, and the revolution of the rotary component 96 is transmitted to a pair of rotating discs 100 and 102 to rotate the driving pulley 104, and then transmitted through the timing belt 108 to the  
25 driven pulley 106, which is attached to the cleaning roller 48, and thus, eventually the cleaning roller 48 is rotated. To the contrary, the swing arm 90 is biased by resilient force of the spring 92 toward the substrate W, and the

cleaning member 52 attached to the outer peripheral surface thereof (see Fig. 3) is brought into contact with the end face and/or the bevel face of the substrate W.

According to this embodiment, by way of applying an appropriate bias force suitable for the rotation speed of the substrate W to the swing arm 90 by the spring 92, the end face and/or the bevel face of a flat oriented portion O of the substrate W having the flat oriented portion O can also be cleaned.

Then, after the cleaning operation has finished, the rotation of the substrate rotating rollers 12 and 14 is stopped so as to stop the revolution of the substrate W and the cleaning roller 48, and each of the pair of support bases 10, 10 is moved away from the other to release the substrate W from gripped condition, where at the same time the swing arm 90 together with a rotary component transfer base 72', a support rod 74' and a bearing 76' as one integral unit moves outwardly, so that the contact engagement of the cleaning member 52 (see Fig. 3) with the end face and/or the bevel face of the substrate W may be released.

Herein, as shown in Figs. 10(a) and 10(b), a contact location adjusting mechanism 112 may be arranged between the cleaning roller 48 equipped with the cleaning member 52 in the outer peripheral surface thereof and a cleaning roller supporter 110 for supporting the cleaning roller 48 so that the contact location of the cleaning member 52 with respect to the substrate W may be vertically adjusted.

That is, in a configuration shown in Fig. 10(a), a bar-like portion 114 is provided in a lower portion of the cleaning roller 48, which includes a plurality of through-holes 114a formed therein as penetrated laterally in a specified pitch in the vertical direction of the bar-like portion 114, and the bar-like portion 114 is inserted into a central hole 110a formed in a cleaning roller supporter 110 and a bolt 116 is inserted through a desired through-hole 114a of the bar-like portion 114 so as to be fittingly coupled by thread with the cleaning roller supporter 110, thus making up the contact location adjusting mechanism 112. Further, Fig. 10(b) shows another configuration, in which a male thread is formed on the bar-like portion 114 provided in the lower portion of the cleaning roller 48 and a female thread to be engaged with the male thread is formed in the central hole 110a formed in the cleaning roller supporter 110 respectively, and further a double nut 118 is engaged with the male thread of the bar-like portion 114 provided in the lower portion of the cleaning roller 48, thus making up the contact location adjusting mechanism 112.

Thus, by providing the contact location adjusting mechanism 112 for adjusting the contact location of the cleaning member 52 in the vertical direction thereof with the substrate W and using the cleaning member 52 as displaced vertically depending on the abrasion thereof, the full width of the cleaning member 52 along the vertical direction thereof may be effectively utilized and thus the cleaning member 52 may be used in economical way.

5 Figs. 11 and 12 respectively show a substrate  
cleaning apparatus 1 and an ultrasonic cleaning liquid  
nozzle 96 according to the fourth embodiment of the present  
invention. In the apparatus shown in Figs. 11 and 12,  
components corresponding to those in Figs. 1 to 10 are  
designated by the same reference numerals, and a duplicated  
explanation therefor should be omitted. The substrate  
cleaning apparatus 1 of Fig. 11 performs a scrub cleaning  
and an ultrasonic cleaning at the same time, in the scrub  
10 cleaning, a cleaning member 52 of a cleaning roller 48  
being brought into contact with the end face 8 and/or the  
bevel face of a substrate W to perform a scrub-cleaning,  
while in the ultrasonic cleaning, cleaning liquid 88 being  
injected from an ultrasonic cleaning liquid nozzle 96 so as  
15 to impinge upon a end face 8 of the substrate W. As  
disclosed in JP-A-2001-53047 (Japanese Unexamined Patent  
Publication), the ultrasonic nozzle 96 is useful in  
cleaning substrate surfaces having a concave portion. The  
substrate cleaning apparatus 1 shown in Fig. 11, which  
20 performs the ultrasonic cleaning and the scrub cleaning at  
the same time, allows the substrate to be cleaned  
thoroughly in a short time.

As shown in Figs. 11 and 12, the ultrasonic cleaning  
liquid nozzle 96 is located so that the nozzle center axial  
25 line (jet flow axial line) 87 may extend in the direction  
normal to the end face 8 of the substrate W so as to pass  
through the center point P, and supplies the cleaning  
liquid oscillated by ultrasonic waves against both of the

top and the bottom surfaces at the same time. The top and the bottom surfaces of the substrate W may be cleaned both by the scrubbing action of the roller brush 42 (see Figs. 1 and 2) disposed along the center line of the substrate and  
5 by the ultrasonic cleaning liquid 88 supplied to the top and the bottom surfaces of the substrate W.

Cleaning of the bevel portion of the substrate may be distinctly improved in cleaning effect by the scrubbing action of the sponge 52 of the cleaning roller 48 and the  
10 cleaning action of the ultrasonic cleaning liquid 88. The cleaning liquid supply to the top and the bottom surfaces of the substrate may be performed by two ultrasonic cleaning liquid nozzles N of Fig. 2, each disposed in the top and the bottom surface sides of the substrate W,  
15 substituting for the single cleaning liquid nozzle 96 of Fig. 11.

#### EFFECT OF THE INVENTION

As has been described above, according to the present invention, a cleaning roller may be rotated as a substrate  
20 rotating roller for rotating a substrate is rotated so that the end face and/or the bevel face of the substrate may be cleaned, without a separate driving source being required exclusively for the cleaning roller. Further, by providing a function for cleaning the end face and/or the bevel face  
25 independently, the function can be easily added to roller sponge cleaning equipment or the like used conventionally and commonly in the industry, and thereby only a simple remodeling should be carried out to deal with the case

where the function is added as a tailored specification or a retrofit, and further the function would not be an obstacle in cleaning the substrate by rotating the substrate at a high speed.